User Manual

SLAM·STICK X™

Vibration - Temperature - Pressure
Data Logger

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SLAM·STICK**X**

General Information

Copyright

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Warranty

Midé Technology Corporation warrants that the Slam Stick X will be free from defects in workmanship and materials in normal use and operation within one year from date of shipment. This warranty only applies when the Slam Stick X is installed, maintained, and repaired in accordance with all of the directions, instructions, diagrams, safety warnings, cautions, and other notices set forth in this manual, and if not damaged by persons, actions, or inactions unrelated to Midé. In the event of any such defect of which Midé is informed in writing within such one year period, Midé's sole responsibility is, at Midé's option, to provide a replacement Slam Stick X at no cost to the Buyer upon the return of the defective product. Requests for compliance with this express, limited warranty shall be honored only when made by the Buyer. Refer to the Terms and Conditions at http://www.mide.com/legal/legal_terms.php#4 for the full legal terms in regard to this warranty.

Safety Precautions

A number of warnings and cautions appear in the text of this technical manual. They are intended to safeguard personnel and equipment from potential hazards or damage during equipment installation, operation, and maintenance. These warnings and cautions will be presented in the following manner.

WARNING: This represents an operating procedure, practice condition, statement, etc., which if not strictly observed, could result in injury to personnel or long term health hazards.

CAUTION: This represents an operating procedure, practice condition, statement, etc., which if not strictly observed, could result in damage to, or destruction of, equipment or a reduction in performance.

In addition to the specific warnings and cautions included in this manual, Midé recommends that all customers install, operate, and maintain the Slam Stick X in accordance with general safety guidelines included in standards published by OSHA.

Introduction

The Slam Stick X has been specifically designed as a wireless vibration data logging system without the need to be wired to an external system, for either the purpose of operation or data recording. The Slam Stick X was designed to work in parallel with, or ideally replace, the cumbersome instrumentation systems typically used to monitor and record vibrations. These systems require accelerometers hardwired to signal processors and then subsequently to data acquisition units. The Slam Stick X allows the user to capture vibration data without the need for wires or modification to the vibrating structure. Logged data is easily viewed through Midé's software package, *Slam Stick Lab*. The user can quickly analyze the data and easily determine the vibration characteristics of the monitored system. Correlating sudden accelerations to known changes in the environment is possible with the time stamping information. The logger also measures and records temperature and pressure data so that these can be monitored over time.

Configuring, charging, and downloading the data from the Slam Stick X to a PC or laptop can be easily achieved through the use of a micro USB cable (included) and the Slam Stick Lab software package. The device appears as an ordinary USB thumb drive, enabling "plug-n-play" use wherever you go – no drivers to install and no special system privileges needed. This software package allows the user to configure the recorder for different sample rates or triggering modes, quickly review recorded vibration, temperature, and pressure data, and export recording data to .CSV format for use with other analysis packages. A copy of the *User Manual*, *Data Sheet*, *Quick Start Guide*, and the *Slam Stick Lab* software are included on the device for convenience. If a *Calibration Certificate* was purchased, it will also be included on the device.

The Slam Stick X can be configured to record immediately, after a user-specified time delay, at a specific time, or in response to a trigger condition (temperature, pressure, or g-level range). The recording duration, sampling rate, and antialiasing filter cutoff frequency are all user configurable.

The Slam Stick X's enclosure was designed to save weight and space so that the device can be securely mounted through the use of double-sided tape on virtually any vibrating surface. The enclosure includes one slot so that the Slam Sick X can be tied to a nearby structure to act as a failsafe if it were to ever become dislodged. The enclosure also includes three through holes so that it can be screwed onto an intended structure.

Midé has designed the Slam Stick X as the next evolutionary step from its original Slam Stick vibration recorder. With the Slam Stick X, Midé has built in additional features, functionality, and robustness while maintaining a small form factor and wireless portability. For more information on the Slam Stick, the Slam Stick X, and a wide range of other products, please go to www.mide.com. Any questions about Midé's products can be asked by emailing service@mide.com or calling 781-306-0609.

Overview of Features

The Slam Stick X is a three axis vibration data logger capable of measuring and recording accelerations at a very high sampling rate so that the user can perform detailed vibrational analysis. A real time clock provides time stamps for all data recorded so that comparisons to real-world events can be made. Pressure and temperature sensors are also included to provide additional environmental data and triggering capabilities. Features include;

- Embedded Triaxial Accelerometer
- Configurable Sampling Rate up to 20 kHz
- Temperature & Pressure Sensors Included
- Time Stamped Data with Local Calendar Time
- Manual & Automatic Start/Trigger Modes
- Rechargeable Battery Life of Over 4 Hours
- Lightweight (40 grams)
- USB Interface for Set-Up & Data Download
- Analysis Software Included
- Temperature Compensating Accelerometer
- 5th Order Hardware Anti-Aliasing Filter
- Calibration Certificate Available

Specifications

For a more detailed overview of the product's specifications, please refer to the Slam Stick X datasheet available at http://www.mide.com/pdfs/slam-stick-x-datasheet.pdf.

Table 1: General Slam Stick X Specifications

Specification	Slam Stick X
Axes Measured	X,Y,Z
Max Acceleration	25 - 100g
Frequency Response	2Hz - 4kHz
Sampling Rate	100 Hz to 20 kHz
Max Recording	>12 hours @ 10 kHz
Storage Size	2 GB
Additional Sensors	Temperature & Pressure
Minimum Operating Temperature	-40 C
Maximum Operating Temperature	80 C
Dimensions	L=3.00 in (76 mm) │ W=1.18 in (30 mm) │ H=0.59 in (15 mm)
Mass	40 grams
Lifetime	3 years
Triggering	Time delay, calendar date/time, pressure, temperature, acceleration

*Slam Stick X has several variants and higher acceleration levels available upon request.

** User selectable with provided software.

Kit Contents

Every purchase of a Slam Stick X includes the data logger, a micro USB cable, three 4-40 bolts, a roll of double sided tape, and three plastic scraper blades. Table 2 assigns part numbers which will be referenced throughout this user manual.

Table 2: Midé's Slam Stick X Kit

DESCRIPTION	PART NO.	QTY
Slam Stick X Data Logger	LOG-0002	1
USB to Micro USB Cable	4868	1
4-40 Bolts, ¾" Long	96006A217	3
3M 950 Adhesive Transfer Tape, 0.75 in x 5 yd	3/4-5-950	1
Plastic Scraper Blades	095394100115	3

Midé recommends that the Slam Stick X be mounted with the included 3M 950 adhesive transfer tape and/or 4-40 bolts. A roll of tape is included with the initial purchase; but additional rolls can be purchased through a variety of distributors including Amazon and Digi-Key.

The included tape is used for calibration. Calibration is not valid if other tape is used. If modification to the mounting environment is possible, 4-40 bolts can be utilized along with the tape.

The plastic scraper blades included with each kit are recommended for removing the tape and cleaning the underside of the Slam Stick X.

Additional bolts can be purchased through McMaster-Carr. The part numbers for the tape, bolts, and plastic blades included in Table 2 are the manufacturer part number used by the distributors.

Figure 1: Slam Stick X package includes the data logger, a micro USB cable, three bolts, a roll of mounting tape, and three scraper blades for tape removal.

Hardware Description

Various external features of the Slam Stick X (LOG-0002) are identified in Figure 2. The three mounting holes are included to use 4-40 bolts to help align the device. The LED indicator is a bi-color LED (green and red) that is used to present to the user various states of the devic. The X-button is used to initiate and end recordings and also to manually cycle through programmed triggers. The coordinate system reference illustrates the axes directions of the device. The tie down slot is included to use a zip tie or a string of some kind to tether the device to a nearby structure as a failsafe if it were to become dislodged. The USB receptacle is for a micro USB cable.
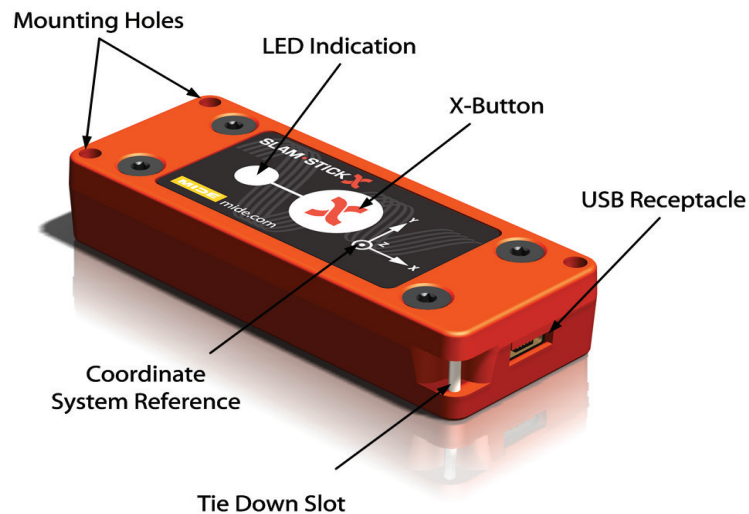

Figure 2: The Slam Stick X is shown with various key features identified.

Quick Start Guide

This *Quick Start Guide* may be used as a reference document on the proper use of the device.

1. **Plug in to charge**
    a. Connect the Slam Stick X to a computer via the USB cable provided.
    b. Charge your device - refer to "Charging Instructions."

2. **Copy files to Computer**
    Copy Documentation, and Software folders to a directory on your computer. The Documentation folder contains the *User Manual*, *Data Sheet*, and *Quick Start Guide.*

3. **Open software**
    Open *Slam Stick Lab.exe* file from the Software folder on your computer.

4. **Set rates & triggers**
    a. Refer to the section entitled "Configuration" for a detailed parameters explanation.
    b. Refer to "Configure Device" for instructions and screen views.

5. **Mount to surface**
    Prior to mounting the device, ensure that the intended environment is suitable by referring to the section entitled "Operational Environment."

    The section entitled "Mounting, Instructions" provides detailed mounting instructions.
    a. The most common form of mounting the device is with the Midé recommended double-sided tape (provided with your kit). Due to the low mass of the product and the strength of the tape, this mounting method is sufficient for most applications.
    b. Three mounting holes of the Slam Stick X allow it to be mounted with 4-40 bolts (included with your kit), allowing the user to better align the device in a desired orientation.

6. **Press X-button**
    Press the X-button to begin recording. If you have configured the device to wait for a trigger, the device will begin waiting after the button is pressed. Refer to the "LED Status" section.

7. **Plug in to view data**
    Following completion, the data recorded by Slam Stick X can be downloaded and viewed using Midé's *Slam Stick Lab* software. Details of the operation of this software are provided in the section entitled "Slam Stick Lab Overview."

    The *Slam Stick Lab* software also enables the user to export the data to a CSV file if desired.

LED Status Indication

The LED indicator designates battery life, specifies operating modes, and indicates potential errors.

When Connected to Power

LED	Battery Status	Action
🟢	Fully charged.	Disconnect from power and use the device for data logging.
🟡	Charging.	Continue charging.
🔴	Battery cannot be charged due to extreme temperature.	Allow the device to reach the allowed charging temperature range (0°C to 45°C). If LED indication persists, contact Midé for assistance.
⚪	Device not operating properly, or not connected correctly.	Check connection, if problem persists, contact Midé for assistance.

During Battery Check - Hold down button until LED turns off

LED	Battery Charge Level	Action
🟢	Above 75%.	The device should be capable to perform as desired.
🟡	Between 20 and 75%.	The device will work; but for a reduced period. Charge if longer recording is desired.
🔴	Below 20%	Charge the device before operation or storage.
⚪	Battery is dead.	Charge the device before operation or storage.

During Operation

LED	Blinking Mode	Status	Action
⚪	No Light	Device is off or sleeping.	Mount the device and press the button, or store the device.
🟢🟡	**2 Sec. Blinking** - *Green to Yellow*	Device is waiting for a time-based trigger.	Allow it to wait for trigger or hold down button to skip to next trigger or recording.
🟢🟡	**1 Sec. Blinking** - *Green to Yellow*	Device is waiting for a pressure or temperature trigger.	Allow it to wait for trigger or hold down button to skip to next trigger or recording.
🟢🟡	**Rapid Blinking** - *Green to Yellow*	Device is waiting for an acceleration trigger.	Allow it to wait for trigger or hold down button to skip to recording.
🟢	**Rapid Blinking** - *Green*	Device is recording. Battery level is above 75%.	Allow it to continue recording or press X-Button to end recording.
🟡	**Rapid Blinking** - *Yellow*	Device is recording. Battery level is below 75%.	Allow it to continue recording or press button to end recording.
🔴	**Rapid Blinking** - *Red*	Device is recording. Battery level is below 20%.	Allow it to continue recording or press button to end recording.

If you experience any issues, please refer to the "Troubleshooting" section.

Transportation & Storage Requirements

The Slam Stick X is an electronic device and therefore its performance, especially battery life, can be severely impacted by the environment it is transported and/or stored in. Midé recommends that the Slam Stick X be both transported and stored at room temperature, 20 to 25°C (68 to 77°F). It is also recommended that the transportation and/or storage environment have a low, <50%, relative humidity (RH).

CAUTION: Be sure to transport and/or store the device in an environment that does not expose it to water, fuel, oil, wet paint or other liquids and contaminants that could damage the Slam Stick X.

Although Midé recommends transportation/storage at room temperature with low humidity, the Slam Stick X has been tested in extreme environments to ensure robustness. This testing includes exposure to -40°C for eight hours and 80°C for eight hours. Extreme humidity testing was also completed which included exposure to an environment of 60°C and 95% RH, non-condensing, for eight hours.

CAUTION: Although the data logger has been tested and proven to survive short durations of extreme environmental conditions, prolonged exposure can drastically reduce battery life and cause the device to be out of calibration.

If the Slam Stick X will not be used for an extended period of time, it is recommended to recharge the device at least twice per year to prevent over discharge. More frequent recharging may be required if stored at high temperatures.

Pre-Operation

Prior to using the Slam Stick X for data logging, it will need to be fully charged and configured.

Charging Instructions

The Slam Stick X is charged by connecting the device to a USB power source with the USB to Micro USB cable as shown in Figure 3.

CAUTION: Be certain to insert the USB to Micro USB Cable into the micro USB receptacle with minimal force to prevent damage. Do not insert the cable at an angle because it can cause damage to the receptacle. Do not hold the button down when connected to power.
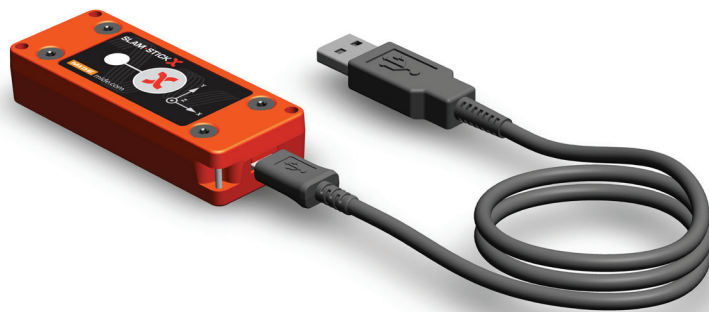
Figure 3: The Slam Stick X is easily charged by using the provided USB to Micro USB cable.

The LED indicator will designate the battery charging state as specified in *LED Status Indication* section. Once fully charged the LED indicator will display a constant green light. It is estimated that a full battery charge will take one to two hours depending on the power source and the age of the battery.

Battery Level Check

To check the battery charge level, press and hold the X-button for greater than three seconds while unplugged from the PC. While the button is held down, the battery life will be indicated by the LED color as specified in "LED Indication" section for approximately three seconds, after which time the LED will turn off. Once the LED indication has ceased, releasing the button will return the Slam Stick X to sleep mode.

NOTE: If only checking battery level, be sure to hold the button until the charge indication completes. Pressing the button for less than approximately three seconds will initiate a recording.

Configuration

Several of the Slam Stick X's recording variables are user-configurable in order to meet various recording needs. Table 3 lists the configurable variables and describes what each represents. The table also defines the range of values that can be entered by the user for each variable, and the default values are also provided. Midé can also instruct the user to change the calibration variables of the device if it is believed that it has gone out of calibration. Midé also offers a recalibration service if desired. Please contact Midé at service@mide.com if recalibration is needed.

Table 3: Configurable Variables of the Slam Stick X.

Variable Name	Description	Default	Value Range
Sampling Frequency (fs)	The frequency at which the Slam Stick X measures and records acceleration data.	5 kHz	100Hz – 20 kHz
Antialiasing Filter Cutoff	Filters out any frequencies above this value to prevent aliasing.	One fifth fs	10Hz to 20 kHz
Oversampling[1]	Hardware oversampling can be disabled to return raw measurement as an advanced option.	Enabled	Enabled or Disabled
UTC Offset	The time difference between Coordinated Universal Time (UTC) and the local time. This value is used to display correct file timestamps on the device.	0	UTC-12 to UTC+12
Wake After Delay	Adds a delay between when the X-button is pressed and the device begins recording.	No delay/ trigger	0 – 86400 s
Wake at Specific Time	Local time and date at which recording will begin after the X-button is pressed.	No delay/ trigger	Anytime in the future
UTC Time	If set, the wakeup time can be entered directly in UTC. If cleared, wakeup time entry is in local time.	Disabled (local time)	Enabled or Disabled
Recording Duration[2]	Limits the duration of each recording to the desired value.	No limit	0 – 86400 s
Re-triggerable[3]	If the recording duration is limited, the device can be programmed to be re-triggerable, where after a recording it begins waiting for the programmed triggers again.	Disabled	Enabled or Disabled
Pressure Trigger (Low)	If enabled, initiate recording when atmospheric pressure is at or below this value.	No trigger	25 to 110 kPa
Pressure Trigger (High)	If enabled, initiate recording when atmospheric pressure is at or above this value.	No trigger	25 to 110 kPa
Temperature Trigger (Low)	If enabled, initiate recording when temperature is at or below this value.	No trigger	-40 to +85C

Temperature Trigger (High)	If enabled, initiate recording when temperature is at or above this value.	No trigger	-40 to +85C
Accelerometer Trigger (Low)	If enabled, initiate recording when the negative-going g-level on any axis meets or exceeds this value.	No trigger	-0g to -max acceleration
Accelerometer Trigger (High)	If enabled, initiate recording when the negative-going g-level on any axis meets or exceeds this value.	No trigger	+0g to +max acceleration
Accelerometer Window[4]	The device will monitor acceleration levels on each axis and begin recording when the g-level on any axis exceeds this value.	No trigger	0 to ± max acceleration

[1]In the oversampling disabled mode, output resolution is limited to 12-bit.

[2]It will record until the battery life expires or the recording duration length is reached, whichever occurs sooner.

[3]It will remain in this state until the device is plugged into power.

[4]Note that this maximum g-level trigger depends on the accelerometer variant purchased.

Time Formats

The Slam Stick X's onboard realtime clock, and timestamps embedded within recording files, are always stored in UTC (Coordinated Universal Time) internally. This provides a standard representation which can be used and shared internationally without needing to know the timezone or special conditions (e.g. Daylight Savings Time) in effect when/where the recording was made. For most practical purposes, UTC and GMT (Greenwich Mean Time) can be considered equivalent.

In the Slam Stick Lab software, times are displayed and entered in local time by default, using your computer's timezone and DST setting (if applicable). The "UTC Time" configuration item can be used to enter a wake-up time trigger directly in UTC, if desired, and the "View -> Show Absolute UTC Time" option in Slam Stick Lab can be used to display recording times directly in UTC.

The file creation times displayed by your computer operating system's file manager are always in local time. The "Local UTC Offset" (timezone) configuration item is used *only* to determine the appropriate local time value when creating the file. This file creation timestamp is for display purposes only and does not affect the UTC timestamps actually recorded inside the file. Recording files can be copied, moved, renamed and otherwise processed without worrying about altering the internal timestamp data.

NOTE: Due to the way some operating systems such as Microsoft Windows handle file timestamp information, the displayed timestamp may differ slightly (typically by one hour) from the actual creation time depending on whether Daylight Savings Time is in effect. This offset does not affect the file's internal timestamp data.

Triggering Options

The Slam Stick X can be configured with one or more trigger conditions, delaying the start of recording until the desired operating conditions are met. If multiple triggers are enabled, they are processed in the following order:

1. Calendar Wake or Time Delay
2. Pressure and/or Temperature window
3. G-Level Trigger.

Once each trigger condition has been met, processing will advance to the next active trigger in this list (the previous condition is no longer monitored). Recording will start once the final enabled trigger condition has been satisfied, even if some of the previous triggers' conditions are no longer present when the final trigger occurs.

For example, the user inputs a calendar wakeup of today at 5 PM, a pressure trigger at 70 kPa, and a g-level trigger of 5 g on any axis, then activates the Slam Stick X by pressing the button. The device will first sleep until the Calendar Wake; other conditions during this time have no effect. Then the device will wait for the pressure/temperature condition. Following the pressure or temperature trigger the device will then wait for the g-level condition. Once the g-level condition is met the device will begin recording.

Triggering Multiple Recordings

Normally, the Slam Stick X turns off at the end of a recording, requiring the X button to be pressed again to initiate a new recording cycle. The "Re-Triggerable" setting can be used to automatically re-arm the triggers after recording and take multiple recordings in a row. This can be used for unattended recording of multiple events or recording at a specified interval. In order to use this feature, a recording time limit must be set so that the first recording will actually stop before the battery or storage capacity runs out.

To automatically record at a specific interval, set "Wake after delay" to the desired idle time between recordings, and set the recording time limit to the desired recording duration. The total interval between the start of each recording will be the sum of the delay and recording times. These settings can also be used with the pressure/temperature or g-level triggers. Setting "Wake after delay" can be used to enforce a latent period between each triggered recording in order to avoid immediately retriggering if the trigger condition persists longer than the desired recording duration.

Bypassing Triggers

When the Slam Stick X is waiting for a trigger condition, press and hold the X-button for at least one second to manually bypass the trigger, automatically advancing to the next trigger or initiating recording. Likewise, pressing the X-button during active recording will terminate recording (including any multi-recording cycle) and shut off the device, regardless of the configured recording time limit or re-trigger setting.

Configuration is performed using the *Slam Stick Lab* software; please refer to the section entitled *Configure Device*.

Device Identification

The Slam Stick X contains internal identification information that is accessible using Midé's *Slam Stick Lab* software package. The information is stored internally and will not be erased by reformatting the device or updating the firmware - please refer to "Configure Device" in the Slam Stick Lab Overview" section to see how to access this information.

A sticker is also included on the exterior of the device to identify the part number and serial number. If a calibration was purchased, there will also be a calibration sticker that indicates the calibration date and expiration date.

LOG-0002-100G	Cal Identity: 0001
Serial No.: 0001	Cal Date: /201

Figure 4: Identification and calibration stickers

Midé logs all devices that are manufactured and keeps all pertinent information about each unit. If provided the serial number, Midé will be able to list all of the information on the particular unit.

Note that the part number is an expanded number from the Slam Stick X overall part number, LOG-0002. This part number, in the format LOG-0002-MAXG, identifies the maximum acceleration range of the accelerometer. The Slam Stick X is available in a range of maximum measurable accelerations; but note that the lesser the measurable acceleration range is the greater the sensitivity and accuracy will be. The numbers 'MAXG' refers to the maximum measurable acceleration level in gs. For example a part numbered LOG-0002-100G indicates a Slam Stick X with a maximum measurable acceleration of 100 g. A part numbered LOG-0002-025G indicates a Slam Stick X with a maximum measurable acceleration of 25 g.

Operation

Operational Environment

The Slam Stick X is rated to operate between -20°C and 60°C. Operation outside of this temperature range is possible; but the device will mark all recorded data outside this range as potentially inaccurate. It is not recommended to use the device in an environment where temperatures exceed 80°C or drop below -40°C. The device can operate in humid environments as well, from 0-95% RH, non-condensing. Operation in low pressure environments is also achievable down to 25 kPa.

The Slam Stick X has been demonstrated to withstand shock accelerations in excess of 250 g. The double sided tape Midé recommends has also been tested to ensure that the device remains mounted and secure for these large shock events. The tape has also been demonstrated to survive severe vibrational environments of over 75 g, vibrating at 1,000 Hz. Midé recommends mounting the device with screws if the environment has more severe shock and vibration levels.

The Slam Stick X is only dust proof and therefore should not be submerged or subjected to direct fluid spray. Midé recommends applying a layer of removable tape over the USB receptacle if the environment is especially dusty of if there is a known risk of fluid spray.

CAUTION: Do not expose the device to water, fuel, oil, wet paint or other liquids and contaminants that could damage the Slam Stick X.

The Slam Stick X has been EMI tested and qualified to the United States Military Testing Standard for Electromagnetic Compatibility (MIL-STD-461F). Test results available here: Test Report (27MB PDF).

Although the Slam Stick X has been demonstrated to survive harsh environmental conditions, it is still an electronic device and care should be exercised when determining where to use the device. It is also recommended to reduce the total duration the device is subjected to environmental extremes.

CAUTION: Operation of the Slam Stick X outside of the recommended environment will void the warranty and could also cause the device to be out of calibration.

If you are unsure if the Slam Stick X can survive your intended operational environment, please contact Midé for assistance. A technical representative can be reached at service@mide.com.

Mounting Instructions

The Slam Stick X should be mounted with 3M Adhesive Transfer Tape 950. The tape should be applied to the Slam Stick X prior to mounting; it is not recommended to apply the tape to the intended surface first. A full three inch strip should be used. Prior to applying the tape to the underside of the device, ensure that the surface is fully cleaned and devoid of dust and small particles. To clean the underside of the Slam Stick X Midé recommends using the plastic scraper blades provided with each kit. A paper towel with a small amount of a cleaning compound such as toluene or denatured alcohol should be used to clean up any remnants of particles unable to be removed with the blades. The tape can be difficult to remove at times, 3M offers a product specifically designed to aid the removal of adhesive which Midé recommends. This product, called the 3M Stripe Off Wheel (part number is 07498), is available from a variety of distributors..

WARNING: Many degreasing and cleaning solvents are flammable and must be kept away from open flames and sparks. Use only under well-ventilated conditions. Do not smoke while using flammable solvents.

CAUTION: Ensure that any cleaning solvent does not contact the USB receptacle. Liquids, especially cleaning compounds, have the ability to electrically damage the Slam Stick X device.

After applying the double sided tape to the underside of the Slam Stick X, the device may be mounted to the intended surface for data logging. Be sure that the mounting surface is also clean and devoid of any dust and small particles. After the area has been cleaned and is dry, the Slam Stick X can be mounted. A few pounds of force should be exerted on the Slam Stick X by hand to compress the tape and better fix the device in place.

CAUTION: The Slam Stick X has a plastic enclosure; therefore the user should not overstrain the device when mounting it to a surface, or use a metal blade to clean the surface.

Be sure to note the mounting orientation of the Slam Stick X. Midé recommends taking a photograph after mounting the device so that the orientation can be verified after data logging. The membrane on the outside of the device includes a coordinate system reference, which is further explained in Figure 5. If the device is being mounted in an environment with a preexisting coordinate system, such as an aircraft, be sure to align the device's coordinate system with that of the environment. If this is difficult to align perfectly, note how the two coordinate systems are positioned in relation to one another. This will help with data analysis and ensure that data recorded on the device can be correlated to "real world" events known by the system/environment.

Figure 5: The X and Y axes are as indicated. The Z axis is in the direction "out of the page," orthogonal to the X and Y axes.

The Slam Stick X includes one tie-down slot. This slot is included so that a zip tie or a similar tie-down mechanism can be used to provide a failsafe if the device were ever to become dislodged. Although tests performed by Midé indicate the recommended tape is capable of keeping the device secure even when subjected to high accelerations and vibrations, this cannot be guaranteed for all possible environments, mounting surfaces and vibration conditions. Therefore, use of the tie-down mechanism is recommended to prevent the possibility of user injury or damage to the device or its operating environment. The tie-down slots are metal-reinforced and have been rated to withstand a pulling force of 50 pounds. The tie-down slots are not recommended for securing the device directly to a vibrating structure, merely as a means to act as a failsafe in the event of dislodgment. Refer to figure 6.

CAUTION: Although the tie-down slots have been reinforced with steel dowel pins, overstraining these slots can damage the device's enclosure.
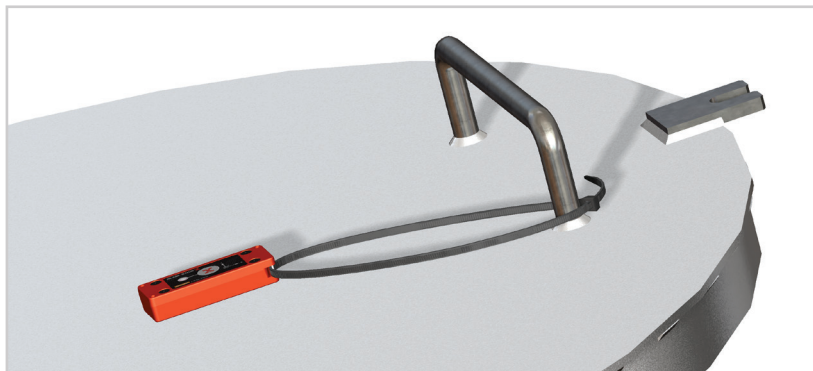

Figure 6: Illustration of how a zip tie can be used as a fail safe to help secure device.

CAUTION: Failure to properly secure the device could result in personal injury or damage the device or nearby equipment if it were to become dislodged.

Although the double sided tape has been tested and qualified to keep the device secure in harsh environments, Midé has included three mounting holes in the Slam Stick X enclosure to enable a more secure mounting method. These holes were designed for 3 x 4-40 screws, with a recommended length of at least 11/16", to be used for mounting. The holes have a bolt pattern of 0.93" x 2.75" as indicated in Figure 7. It is recommended to still use the double sided tape when mounting with screws to further stabilize the device and maintain consistency with qualification testing and calibration. Do not over torque the screws, Midé recommends torquing the screws to 3 lbf-in.

Figure 7: The enclosure includes three through holes to enable mounting with 4-40 screws.

Recording Data

After the Slam Stick X has been configured, mounted and secured, it is ready to record. Simply press the X-button to begin recording or waiting for triggers. Refer to Table 4.

Table 4: LED Indication During Operation.

LED	Blinking Mode	Status	Action
⚪	No Light	Device is off or sleeping.	Mount the device and press the X-Button or store the device.
🟢🟡	2 Sec. Blinking - Green to Yellow	Device is waiting for a time-based trigger.	Allow it to wait for trigger or hold down button to skip to next trigger or recording.
🟢🟡	1 Sec. Blinking - Green to Yellow	Device is waiting for a pressure or temperature trigger.	Allow it to wait for trigger or hold down button to skip to next trigger or recording.
🟢🟡	Rapid Blinking - Green to Yellow	Device is waiting for an acceleration trigger.	Allow it to wait for trigger or hold down button to skip to recording.
🟢	Rapid Blinking - Green	Device is recording. Battery level is above 75%.	Allow it to continue recording or press button to end recording.
🟡	Rapid Blinking - Yellow	Device is recording. Battery level is below 75%.	Allow it to continue recording or press button to end recording.
🔴	Rapid Blinking Red	Device is recording. Battery level is below 20%.	Allow it to continue recording or press button to end recording.

At any time during a recording the user can press the X-button to stop the recording. If the button is pressed while the device is waiting for a trigger it will skip to the next specified event. Once a recording event has been triggered, pressing the button will end the recording.

The user can press the button again to reactivate the device, or to immediately begin recording. This will depend on configuration, and adequate battery life.

There is a brief delay between pressing the X-button and the start of recording (approximately 1/2 second) to allow the accelerometer to settle during power-up. This startup delay, plus any user-specified delays or triggers, is reflected in the recording start time displayed by Slam Stick Lab.

The rate the LED flashes at during recording is loosely proportional to sampling rate, and may range from once per several seconds (at very low sampling rates) to many times per second (at high rates). During recording, the flashing of the LED may occasionally skip. This is normal and not a cause for concern.

Recording File Naming and Folder Structure

The Slam Stick X will place recording files in the \DATA\ folder, followed by a subfolder consisting of the date of the recording in YYYYMMDD format. Each recording's filename will consist of "SSX" followed by a number that increases for each recording, based on the number of seconds that have elapsed since the start of that day. These files can be sorted by date or alphabetically to display in

the order they were recorded. For example, a recording performed on July 24, 2014, at 8:00am will be at \DATA\20140724\SSX28800.IDE .

The Slam Stick X also contains a \SYSTEM\ folder, which houses the configuration file and various system files. It is not recommended to alter or delete these files. If a system file was accidentally deleted, it will be automatically recreated the next time the Slam Stick X is plugged in.

The Slam Stick X also contains a \SOFTWARE\ folder where the Slam Stick LAB executable file is located, as well as a \DOCUMENTATION\ folder that contains the *User Manual, Data Sheet, Quick Start Guide*, and *Calibration Certificate* (if purchased). Midé recommends copying all folders and data files from your Slam Stick X to a local folder on your computer - then using the copied files.

The user may store his or her own files on the device, such as test procedures, copies of software or manuals, or other materials. If this is done, please avoid placing any files in the \DATA\ or \SYSTEM\ folders. Note that placing large or numerous files may adversely affect the maximum recording rate or capacity.

Slam Stick Lab Software Overview

The primary function of the Slam Stick Lab software application is to import and display data from the Slam Stick X data logger. It is also used to configure the Slam Stick X to meet various recording needs. A major feature of the software is that it operates asynchronously; data can be viewed as it is read from the device or file. This is especially important due to the potential very large datasets that the Slam Stick X can record (>500 million samples). Midé is committed to offering a robust and user friendly software package to its customers; it welcomes any suggestions on potential improvement areas.

To run the Slam Stick Lab package simply copy the software folder on the device onto the hard drive of a local computer. The application file with the Slam Stick Lab logo, called *Slam Stick Lab.exe*, can be double clicked to run the software.

Configure Device

While data recorders appear as USB storage devices, the Slam Stick Lab provides a more verbose UI for selecting attached devices. Recorders are displayed by their filesystem path (e.g. a drive letter under Windows), user-specified device name, factory-defined device type name, and device serial number. Additional information about a device is displayed under the device list. To configure a device open the drop-down menu, Device, and then Configure Device (Ctrl + D) as shown in Figure 7.
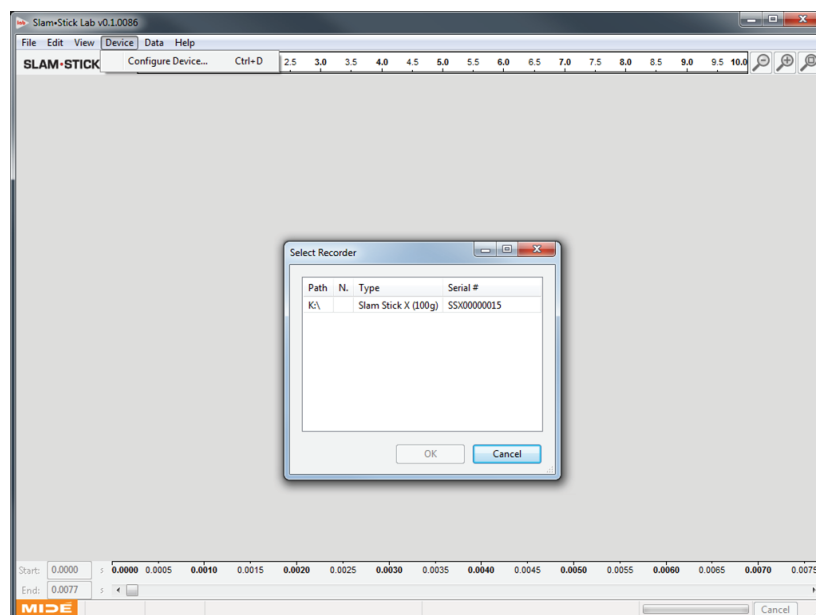

Figure 7: To configure a Slam Stick X, use the Device drop-down menu.

The Configure Device dialog, shown in Figure 8, provides a UI for configuring the device, as well as displaying more information about the device. The configurable variables are explained in more depth in the "Pre-Operation" section.
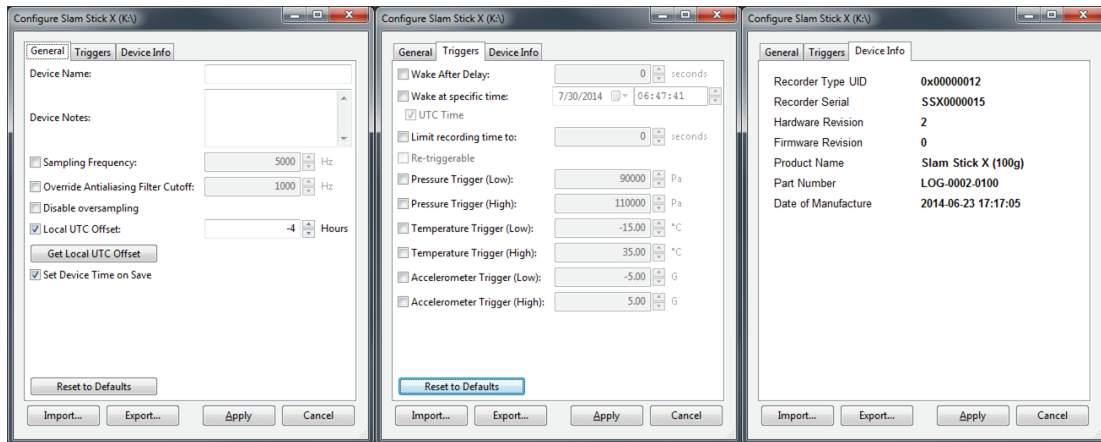

Figure 8: Configuration of various variables is made possible through the device configuration dialog box.

Under the General tab, various global properties of the recorder are displayed, such as the device name and the desired sampling rate. Under the Triggers tab, the user can define the values for the various trigger parameters. A recording can be triggered by sensor readings, an absolute time, or a time relative to when the recorder is powered up. Under the Device Info tab, read-only information about the device is displayed. The contents of this tab are dynamically-generated from the data that the recorder makes available.

Also included in the configuration dialog box are buttons to return the general settings and triggers to the default values. Configuration settings can also be saved and imported using the Import/ Export buttons. In both cases, the device name and notes will not be changed.

To complete the configuration of the device, hit the Apply button. A dialog box will appear confirming the successful confirmation of the device.

Data Analysis

Open Recording

To open a recording, use the File drop-down menu and select Open as shown in Figure 9. The keyboard shortcut Ctrl+O can also be used to open a file. Please note that the software will open the files faster if they have been copied onto a computer first.
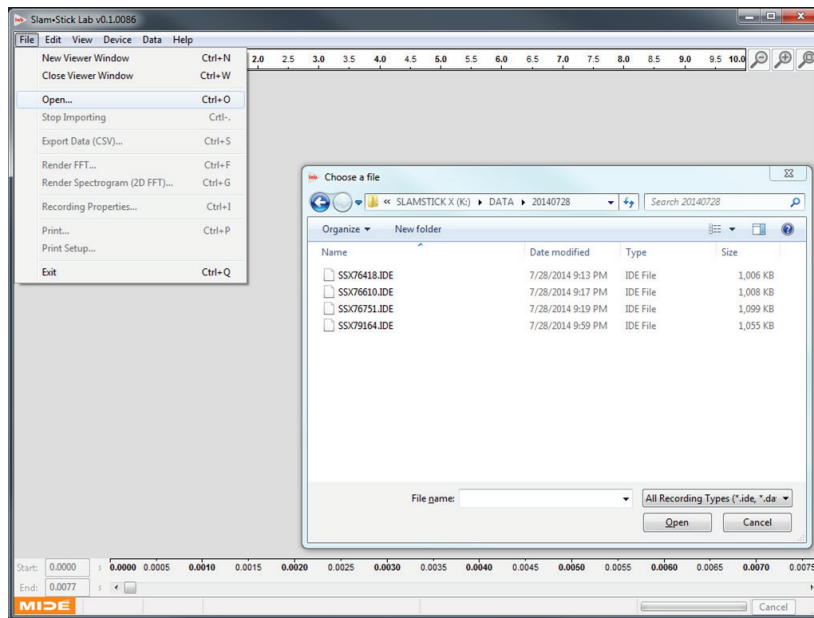

Figure 9: Recording files (.ide) can be opened using the File drop-down menu.

Main Plot View

The main view is divided into several sections: the time navigator, the plot view, and the status bar as shown in Figure 10.
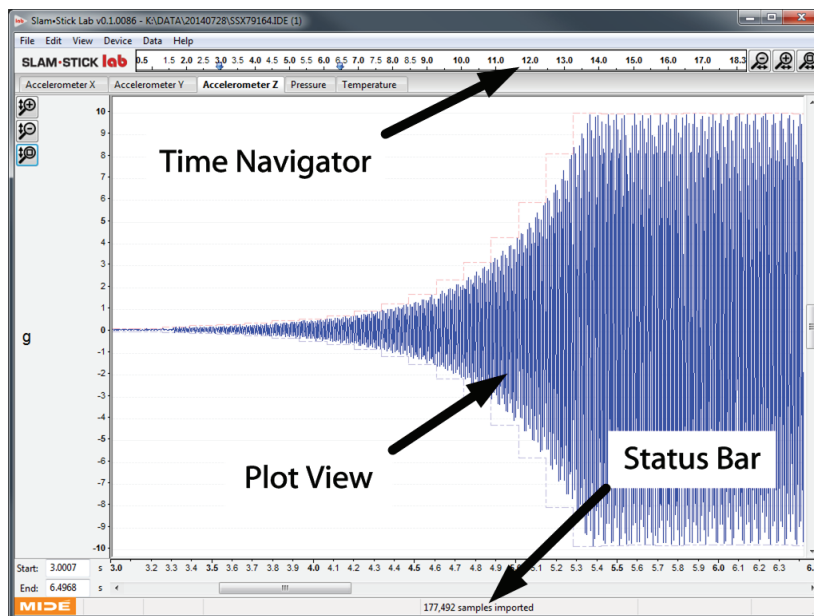

Figure 10: The main view of the Slam Stick Lab viewer is shown.

Time Navigator

The time navigator displays the entire recording interval and allows the user to zoom in and out of a particular time range of interest. Figure 11 and Table 5 identify and explain various features of the navigator.
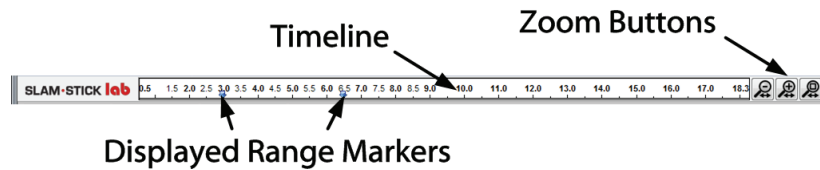

Figure 11: The time navigator view enables the user to control the time range of the presented data.

Table 5: Various Features of the Time Navigator.

Title	Description
Timeline	The timeline displays the start and end times of the entire recording. This display updates dynamically when importing data from the recorder.
Displayed Range Markers	The blue markers indicate the range currently displayed in the Plot View. These update dynamically when the Plot View is scrolled. These markers can be dragged to quickly specify a range to display.
Zoom Buttons	The Zoom Out button increases the length of the range currently displayed in the Plot View (the horizontal axis). The Zoom In button decreases the length of the range currently displayed in the Plot View (the horizontal axis). The Zoom to Fit button zooms out to fit the file's entire time range.

The start time of the recording is counted from when the recording was first initiated by pressing the X-button, not when the first sample is recorded. Therefore, the first recorded data sample may not necessarily start at 0, especially when using a triggered mode. The time offset where the recording starts can be used to determine how much time elapsed between the start of a recording cycle and the trigger event.

Plot View

The plot view enables the user to view the data recorded on the Slam Stick X and also to compare various data channels with one another. The plot tabs can be dragged into various areas of the viewer window to aid in the comparison of data channels. This is done by clicking on the shown tab and dragging into the desired location as shown in Figure 12. The location that the plot will appear will become shaded in blue, at this time the mouse can be released to redraw the plot in that location.
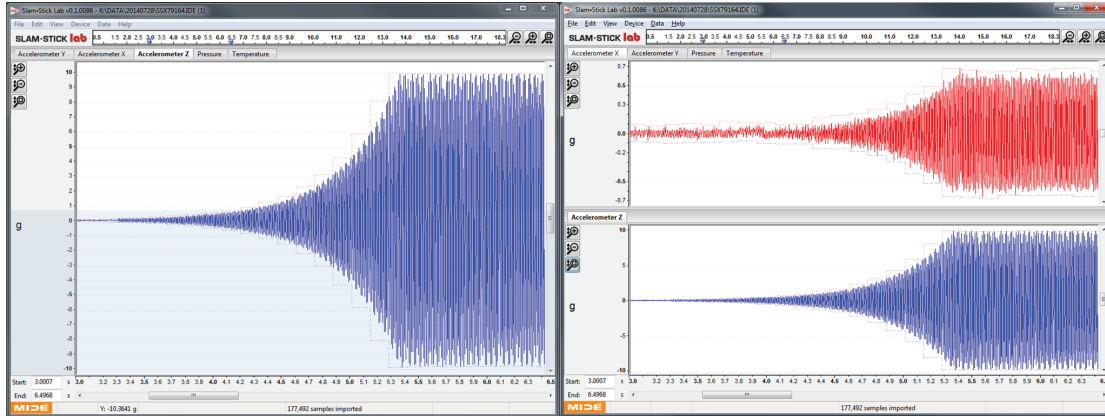

Figure 12: Multiple plots can be viewed together by dragging tabs into different areas of the window.

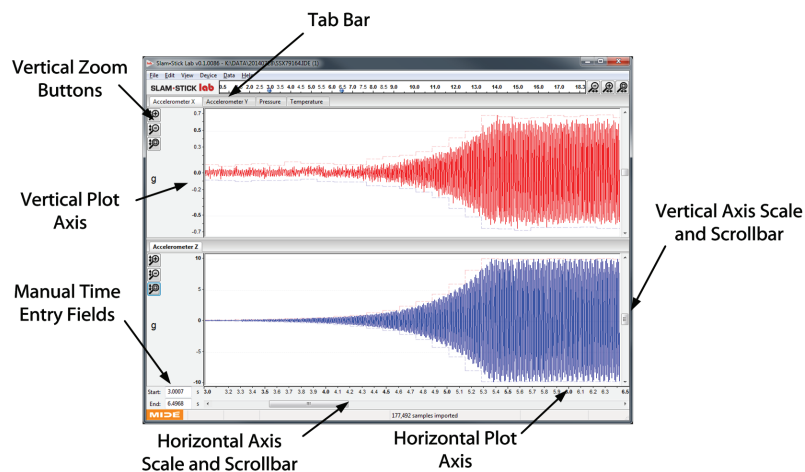Figure 13 and Table 6 identify and explain the various features available to the user in the plot view.

Figure 13: Various features of the plot view are identified.

Table 6: Various Features of the Plot View.

Title	Description
Tab Bar	The Tab Bar shows a tab for each sample set. The tabs can be dragged to reorder, and more than one plot can be shown simultaneously by dragging a tab from the bar into the main view. Tabs can be dragged from one tab bar to another.
Horizontal Axis Scale and Scrollbar	The scrollbar below the horizontal axis scale moves the current timespan displayed. Clicking and dragging on the horizontal axis scale bar allows for precise adjustment.
Vertical Axis Scale and Scrollbar	This scrollbar enables the user to control the range of vertical axis values being presented.
Manual Time Entry Fields	The start and end of a specific time range can be entered here to accurately zoom into or out to an intended time range.
Vertical Zoom Buttons	These increase and/or decrease the scale of the vertical axis. The first two, Zoom In and Zoom Out, scale by a fixed amount. The third button, Zoom-to-Fit, adjusts the displayed minimum and maximum to best fit the range of values currently displayed.
Vertical Plot Axis	The vertical axis displays the values of the respective plot's data channel. The units of this axis are displayed below the zoom buttons. Clicking on this axis also enables the user to precisely adjust the viewable range.
Horizontal Plot Axis	The horizontal axis displays the time range of the respective plot. The units of this axis are always in seconds.

Also note that a plot can be zoomed in by left clicking a box around the area of interest in the plot. Right clicking in the plot window will incrementally zoom out.

Status Bar

A status bar is located on the bottom of the window to present information to the user during data importing and about the plotted data. Due to the large potential file size of datasets recorded on the Slam Stick X, it can take upwards of an hour to import the entire dataset. The viewer software was designed to allow the user to dynamically view and export data as it is imported. The status bar indicates to the user the progress of the data importing. Figure 14 and Table 7 identify and explain the various features and information presented in the status bar.
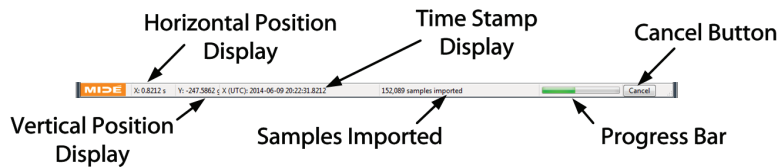

Figure 14: The status bar presents valuable information to the user during data import and while plotting data.

Table 7: Various Features of the Status Bar.

Title	Description
Horizontal Position Display	When the mouse pointer is within a plot area the x coordinate of the plot is displayed in the units of the plot.
Time Stamp Display	When the mouse pointer is within a plot area the time stamp of the data points the cursor is over are displayed.
Vertical Position Display	When the mouse pointer is with a plot area the y coordinate of the plot is displayed in the units of the plot.
Samples Imported	When the viewer is working in the background, this status message displays the number of samples recorded during data importing.
Progress Bar	This provides a visual display of the progress of the full data import.
Cancel Button	This button enables the user to cancel importing during the import process.

Menus and Options

The functionality listed here is accessed via the Slam Stick Lab's drop-down menus.

Mean Removal and Buffer Minimum/Maximum/Mean

The Slam Stick X saves the minimum, maximum and mean of each "Buffer" of data that is written to disk. A "Buffer" is about 4,000 data points, so the frequency of these is directly proportional to the sampling rate. The Slam Stick Lab software enables the user to utilize the buffer information in two ways.

First, it uses the buffer means to determine the DC offset of the accelerometer channel. The default is to remove the total mean which is determined by finding the median of all of the buffer means. The DC offset of the accelerometer drifts with temperature, however, for long recordings where temperature is changing, it may be desirable to remove the "rolling mean." This removes the median of the buffer means for just a subset of the entire dataset to allow for this to compensate as the DC offset drifts. The user can select the type of mean/median removal they'd prefer through the Data drop-down menu as shown in Figure 15. If no mean removal is selected, there will be a DC offset in the data.
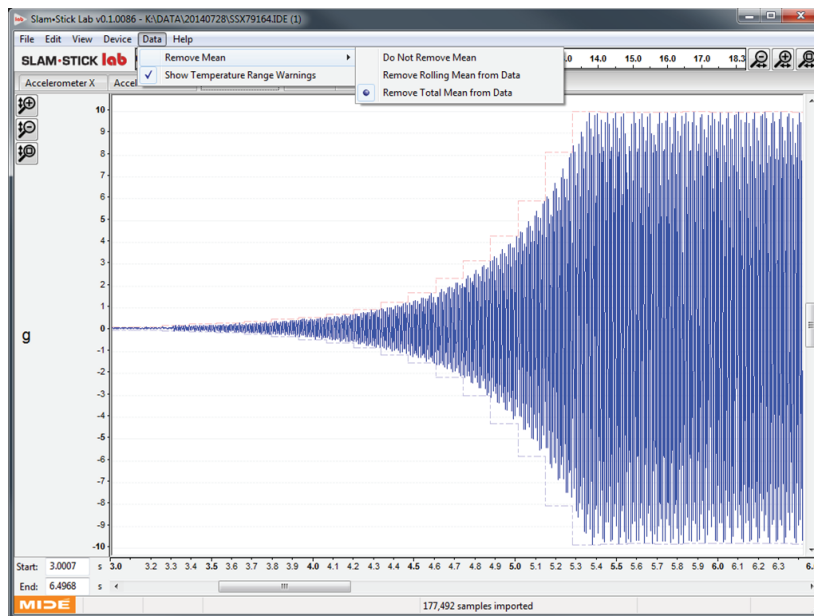
Figure 15: The "mean removal" is used to compensate for thermal DC drift of the accelerometer.

Buffer data is also utilized to help illustrate the moving maximum and minimum acceleration level bands. The Slam Stick Lab does not plot every data point (discussed more in Section View Settings), so when zoomed out of a dataset it can appear that the vibrations were less dense and/or less severe than in actuality. The Buffer Maximum and Minimum display can help visualize how the maximum and minimum acceleration levels are changing with time. This can be especially helpful when plotting data over a long time period.
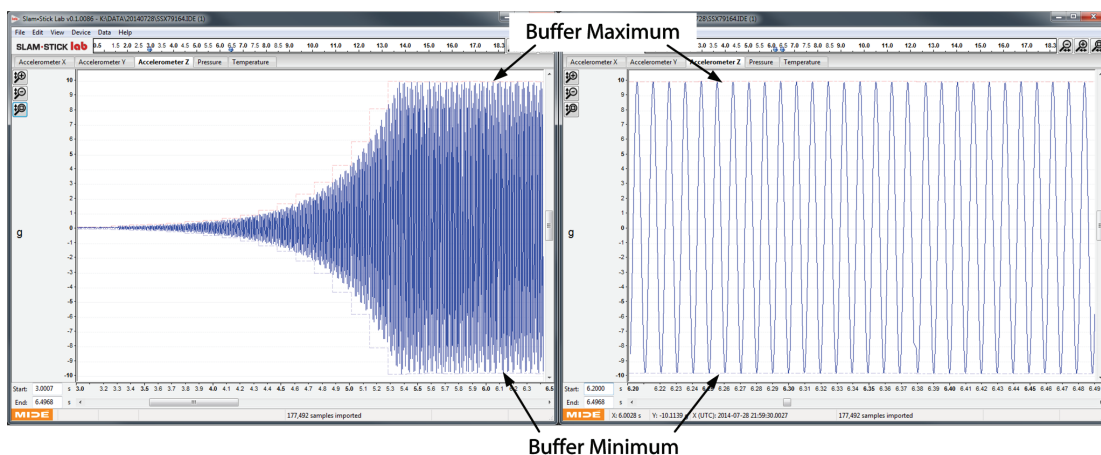

Figure 16: The buffer minimum and maximum lines display how the maximum and minimum acceleration levels are changing with time.

When there are more buffers than the number of pixels on the screen, the Slam Stick Lab plots just the buffer maximum and minimums as shown in Figure 17. This is done to enable faster drawing times and to provide a clear visualization on the acceleration data extremes. The data used to generate the shown plot was generated from a frequency sweep when sampling at 10 kHz. The sweep is very similar to the one shown in Figure 16; but for that plot, the device was only sampling at 1 kHz.
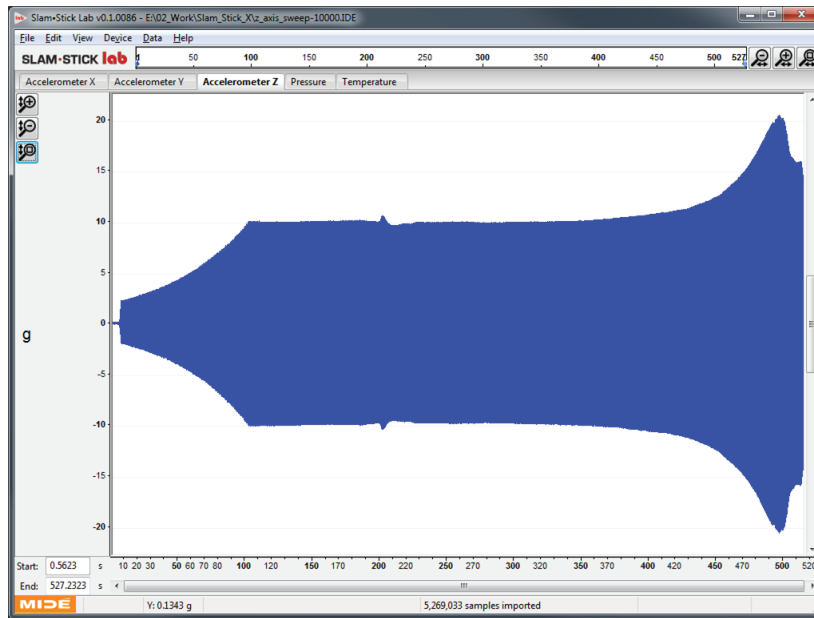
Figure 17: When there are more buffers then pixels on the screen, the Lab will plot all the buffer max and minimums instead of data points for optimization purposes.

Recording Properties

Once a recording has been loaded, Slam Stick Lab can display information on the recording file and on the device that generated the recording. To access this information click on Recording Properties under the File drop-down menu or use the keyboard shortcut Ctrl+I as shown in Figure 18.
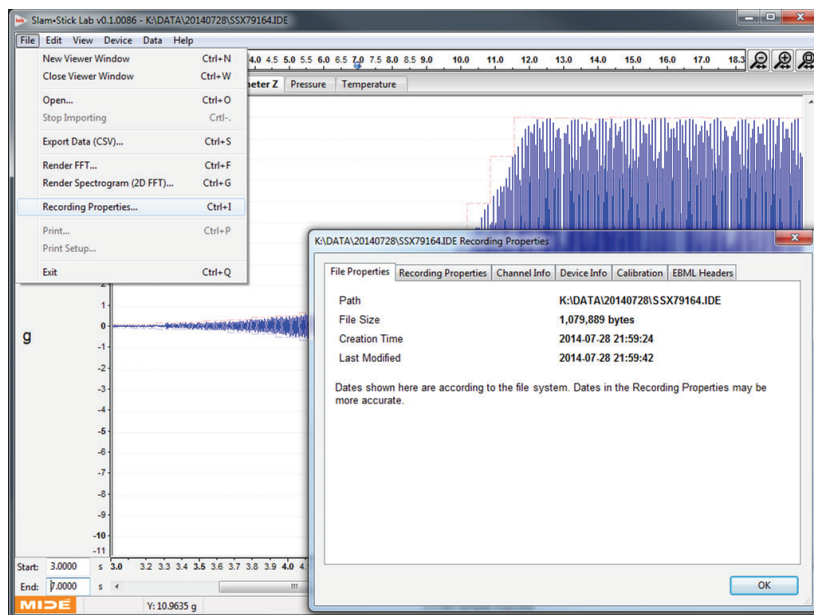

Figure 18: The recording properties dialog box is accessed in the File drop-down menu.

The various tabs and information included in this dialog box are shown in Figure 19. The file size, and recording start are some of the information included on the recording. The part number, date of manufacturing, calibration date, calibration expiration date, and serial number are some of the information included on the device used to generate the recording.

Midé also includes the sample rate, sensor range, and maximum and minimum value of each channel. The time at which the maximum and minimum value occurred is also provided. In the Calibration tab there are the equations used to calibrate the raw data. The univariate equation is applied to all accelerometer channels to convert the raw signal to gs. The 'x' in the equation is the raw signal. The bivariate equations are the x axis, y axis, and z axis calibration in that order. In these equations the 'x' is the raw signal already converted to gs, and the 'y' variable is the temperature measured in degrees C.
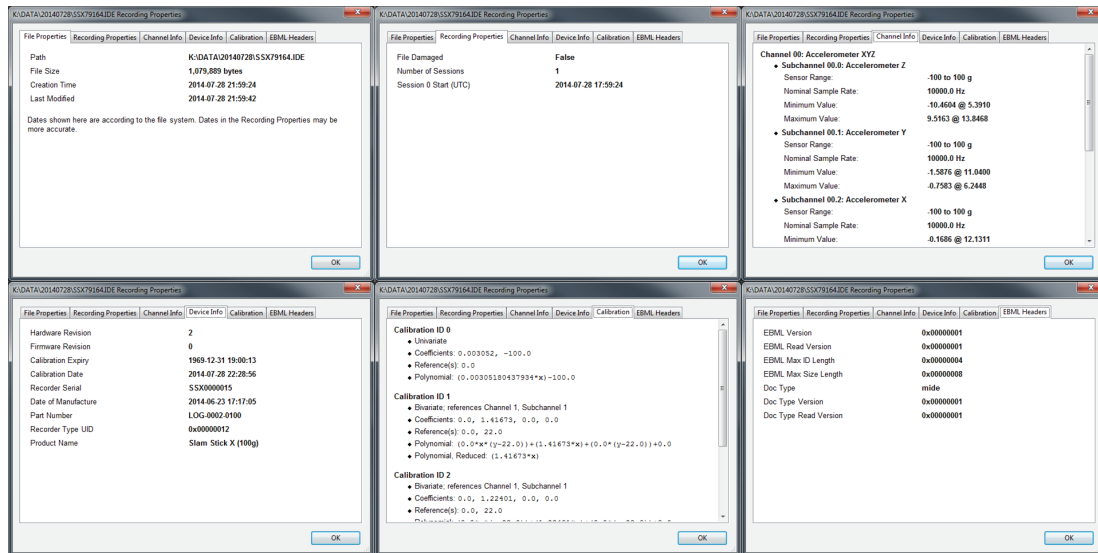

Figure 19: The Recording Properties dialog box presents a lot of information on a particular recording, and on the device used to generate the recording.

View Settings
The View drop-down menu provides various features and settings to the user to manipulate how the plotted data is displayed. The features and keyboard shortcuts are shown in Figure 20 and explained in Table 8.

Table 8: View Setting Features.

| Title	Description
Redraw Plots	When the window size is modified the plots don't always redraw automatically. This feature redraws all plots.
Edit Visible Ranges	This allows the user to manually enter the axis ranges for the selected sensor channel.
Zoom	These are shortcuts to zoom in and out. Note that left clicking and dragging a box in a plot window will zoom into that range and right clicking will zoom out.
Set Plot Color	The color of the selected channel can be modified.
Antialiased Drawing	This scales up the number of data points plotted as specified in the preferences dialog box. This will smooth out the plot lines.
Noisy Resampling	This tries to combat aliasing in plotted data by randomly "jittering" around the number of data points between each plotted point.
Show Buffer Data	The buffer minimum, maximum, and mean can be toggled on or off.
Gridlines	The major and minimum gridlines can be turned on or off by the user.
Show Absolute UTC Time	This will show the absolute UTC time in the status bar.
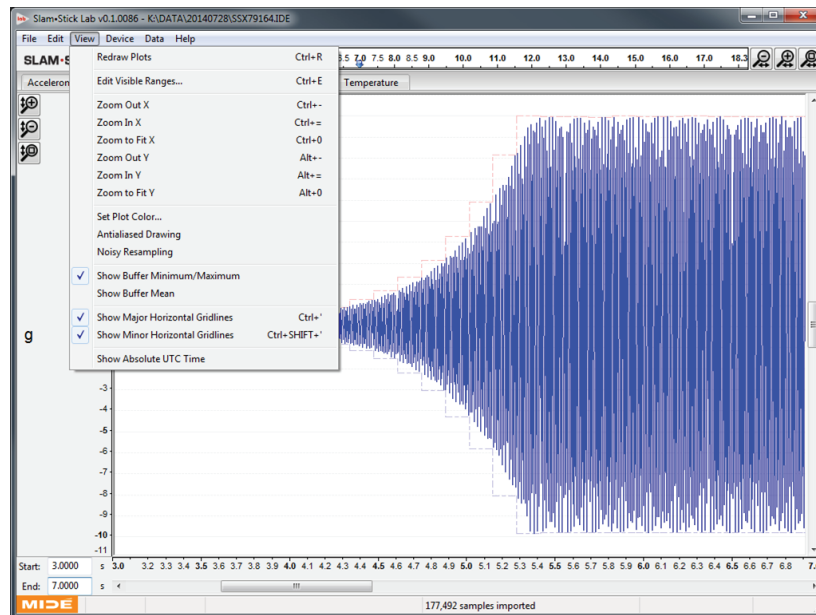
Figure 20: The View drop-down menu provides various settings and features to the user to manipulate how the plotted data is displayed.

Preferences

Under the Edit drop-down menu is the Preferences dialog box as shown in Figure 21. Preferences include specifying the color of gridlines and buffer mean/maximum/minimum, modifying the default on mean removal, the amount of time used to compute the rolling mean, whether or not individual data points will be drawn (if the number of pixels on the screen is greater than the number of points), the antialiasing scaling factor, the resampling jitter factor, and the value precisions for the axes (number of significant digits of plotted data).

The Slam Stick Lab will also check for automatic updates at the user specified interval in this dialog box. Various information and warning dialogs provide the option to prevent that dialog from appearing again. Saving the Preferences with the Reset Hidden Dialogs and Warnings checkbox checked will make all warnings visible again.
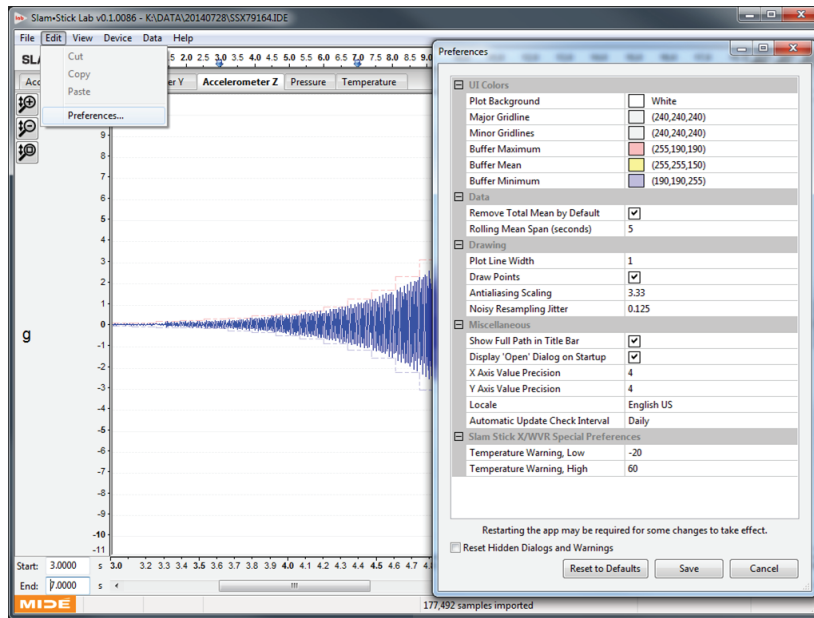
Figure 21: Preferences are selectable to improve the user experience.

Export CSV

One function accessible via the File drop-down menu is Export to CSV. This will bring up a dialog box, as shown in Figure 22, which is used for selecting channels and the time range for export as comma-separated values. Table 9 explains how the user can define what information to export.
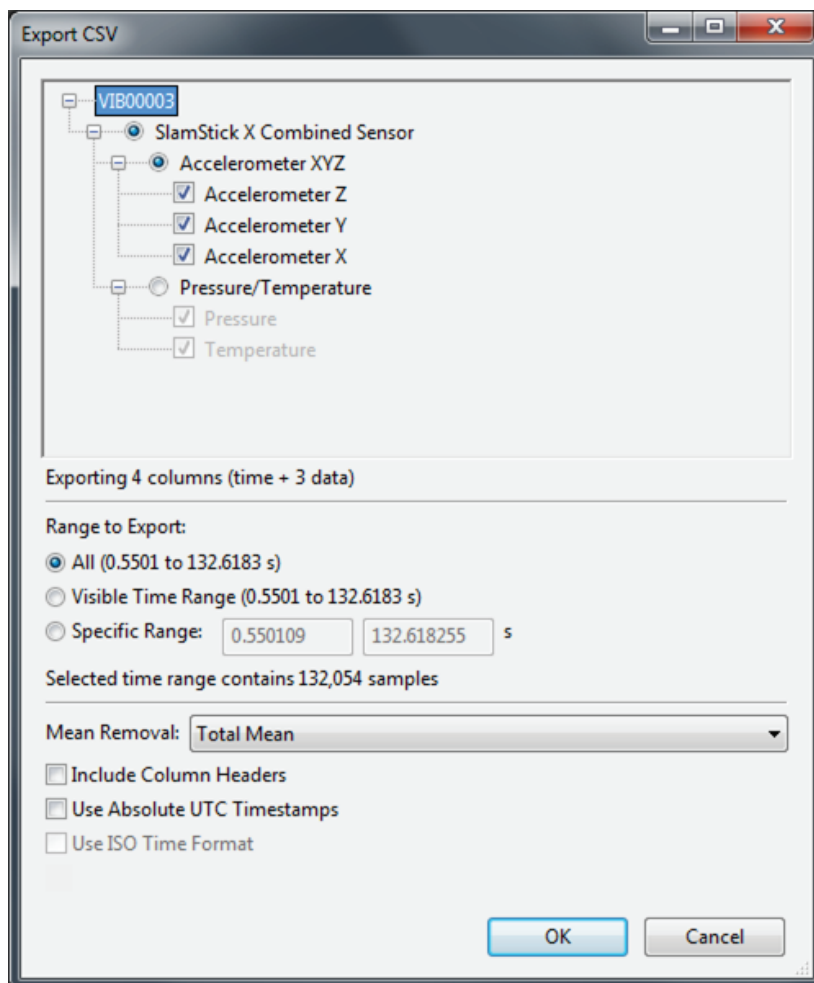
Figure 22: The export dialog box enables users to export data channels to a CSV file.

Table 9: Various Features of the Export Dialog Box.

Title	Description
Channel Selector	The various sensor data channels/sub-channels are listed in a hierarchical format. Different sub-channels of the same channel can be exported together; sets of channels/sub-channels with different sample rates must be exported separately.
Range Selector	Select time ranges of samples can be selected for export. The number of samples within the specified interval is also displayed. If *All* is selected, all samples in the full time range of the dataset will be exported. If V*isible Time Range* is selected, the range displayed in the main view will export. If *Specific Range* is selected an explicitly-defined interval will export.
Mean Removal	The user has the ability to select what type of mean removal to apply for the exported data.
Include Column Headers Box	If checked, the first row of the exported CSV will contain the column names.
Absolute UTC Timestamps	If checked, the time column will display as the UTC timestamps (time 0 is the start of 1961).
Use ISO Time Format	If checked, this will make the UTC timestamps more human-readable to read as the date and time within the day.

Render FFT and Spectrogram

The Slam Stick Lab Viewer can also be used to render a Fast Fourier transform (FFT) or spectrogram (2D FFT). The spectrogram slices the recording into shorter time segments and performs FFTs for each time segment to display the frequency content over time as a surface plot. This may help provide a clearer picture of vibration events over time, for example, differentiating constant or repeating shock/vibe events from high-amplitude but non-repetitive events, even though they may produce similar amplitude peaks in the 1-D Fourier results.

Because a recording can contain tens of millions of individual samples, the user interface (UI) provides a means of selecting a specific interval to calculate an FFT or spectrogram for. Also, the spectrogram UI allows for the selection of the number of slices per second in the spectrogram calculation. The Render FFT dialog and the Render Spectrogram dialog have much of the same functionality as the Export CSV dialog; as shown in Figure 23. Table 10 explains how to perform the FFT or spectrogram analysis.
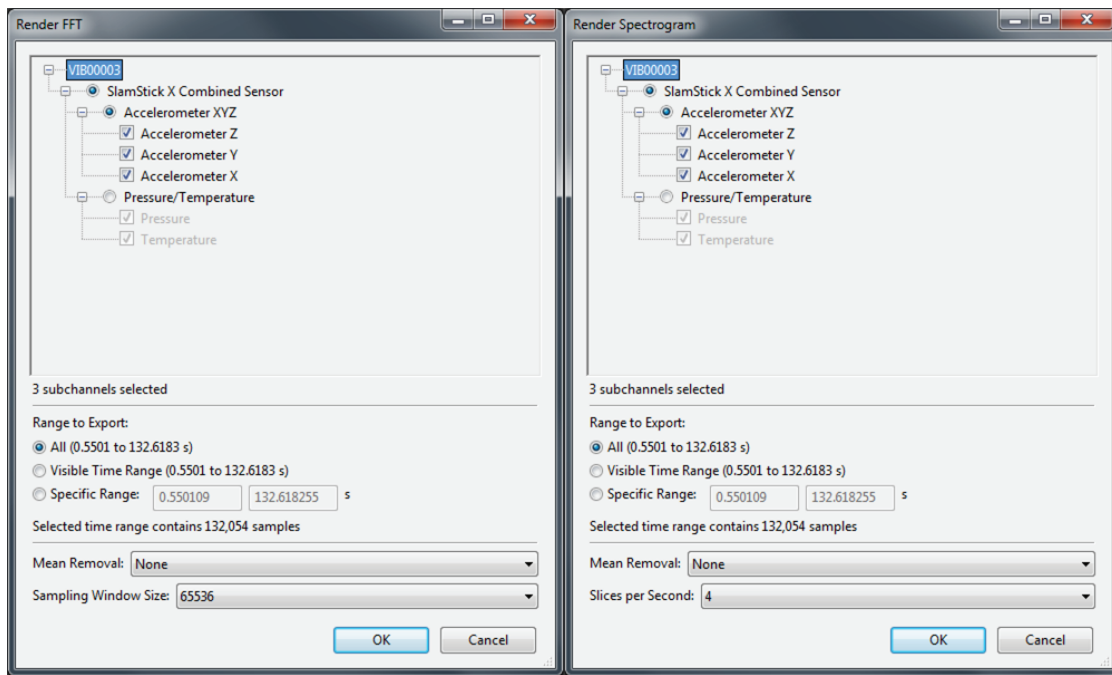
Figure 23: The render FFT and render spectrogram dialog box allows the user to specify a range of data to perform the analysis.

Table 10: Various Features of the FFT and Spectrogram Dialog Boxes

Title	Description
Channel Selector	This functions almost identically to its counterpart in the Export CSV dialog. As with the export, FFT data for sets of channels/sub-channels with different sample rates must be computed separately.
Range Selector	This functions almost identically to its counterpart in the Export CSV dialog. This area also displays warnings if the number of samples in the specified time range is likely to require more memory than is available. Because this is a very rough estimate, these messages are only warnings and will not prohibit an attempt to compute FFT data from an overly-large dataset.
Sampling Window Size	FFT computation is done via Welch's Method, utilizing a size-limited sliding window. The size of the window can be adjusted; a smaller window may conserve memory at the cost of increasing the minimum frequency computed.
Slices Per Second	This defines the number of slices per second the spectrogram calculator breaks the data into. The greater the number of slices, the better resolution of the plot but this comes at the expense of computation time and memory.

Figure 24 provides sample plots using the Slam Stick Lab software. Midé used its shaker to generate this data. In the test the shaker swept in frequency from 15 Hz to 4 kHz at a near constant amplitude of 10 gs while sampling at 1 kHz. The FFT and spectrogram were generated for a subset of that sweep as shown. After generating a FFT or spectrogram the Lab enables this data to be exported to a CSV format for manipulation or further analysis.
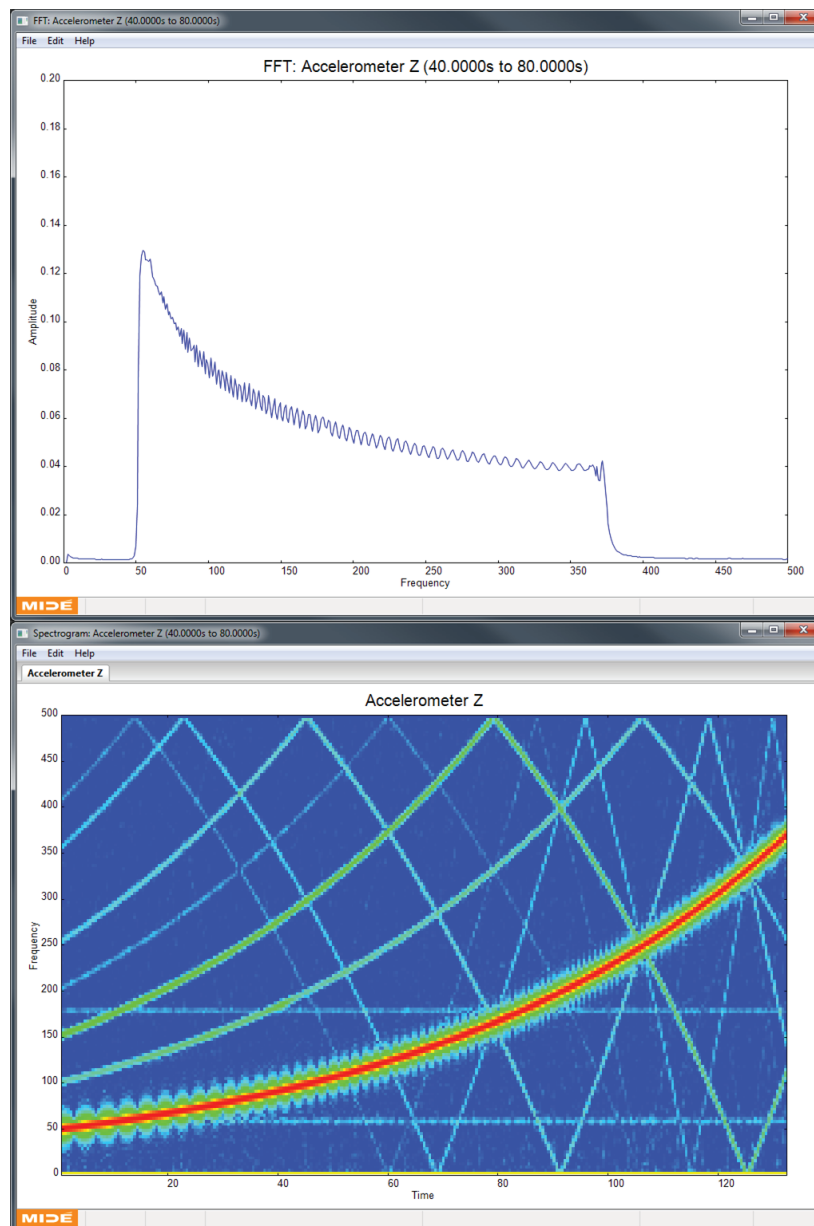

Figure 24: Sample FFT and Spectrogram plots are shown. Midé performed a test on its shaker to generate this data where it swept up in frequency.

Troubleshooting

Some common problems that require simple fixes are presented in Table 11 for troubleshooting. If you experience an issue that is not covered in this table or if the suggested actions do not resolve the problem, please contact Midé to receive assistance.

Table 11: Troubleshooting Issues with Slam Stick X.

Problem	Potential Cause	Action
No LED activity after pressing the X-button.	The battery charge is depleted.	Plug the device into a power source to charge the battery fully prior to use.
	The LED may have been damaged.	The device should still function as normal but there will be no LED indicators.
After mounting the device and pressing the X-button, there are no new data files.	A recording was never triggered.	Check the configuration settings to ensure that a trigger value has not been programmed. If it has, then this trigger parameter may have never been exceeded.
	The device has run out of storage space	Back up and delete some of the previous data recordings.
	The battery charge is depleted.	Plug the device into a power source to charge the battery fully prior to use.[1]
The Slam Stick X came dislodged.	The structure the device was mounted to experienced significant shocks/vibrations.	Be sure to use the zip tie slots to prevent the device from getting further damaged after becoming dislodged. It also may be best to use 4-40 screws to keep the device secure if future recordings are desired.
	The device may have experienced a direct impact from a foreign moving object.	Be sure to mount and use the device in an environment that is devoid of moving parts and objects that could damage the device.
	The temperature was too low which ruined the integrity of the tape bond.	Download and view the data recorded by the device to determine if and when the temperature dropped too low.
The LED is not on when connected to power.	The X button may have been pressed while connected to power and the device is in "bootloader" mode.	Disconnect the device from power. Wait at least 30 seconds for the device to reboot..

The device does not appear in "My Computer" when connected.	The USB cable is not properly inserted, or debris is interfering with contact	Check the connection to the device and to your computer to ensure it is properly plugged in. Remove any pocket lint or other debris present in the USB receptacle
	There may have been water and dust damage.	Contact Midé to receive further assistance.
	The device is still recording or waiting for a trigger event.	Press the X button until any active triggers or recording have been canceled.
The LED blinks red during or when starting a recording	Less than 20% battery charge remains. If the battery charge is too low to begin recording, the Slam Stick X will emit 3 red blinks and shut down	Plug the device into a power source to charge the battery fully prior to use.
Microsoft Windows presents a dialog prompting to scan and fix the Slam Stick X drive	Some Windows versions present this dialog for some drives not formatted by Windows.	This message is harmless; the user may either proceed with or cancel the scan.

[1]In rare cases, when recording with a low battery, the battery power may run out before the Slam Stick X can finish closing the recording file. If this occurs, the file may not appear even though some data was successfully recorded. If the recording contains important data, a disk utility such as Windows chkdsk.exe may be used to recover the file (enable display of hidden files to see the recovered file). Otherwise, the Slam Stick X can simply be reformatted.

Important: Do not use disk utilities to perform "bad sector" tests on the device. Not only is this type of test not suitable for Flash media, the utility may incorrectly detect "bad" sectors on the device due to the special mechanism the device uses to provide dynamic data via virtual files (such as the clock setting and device information).

Product Support

For technical support, repair, and returns please contact Midé's Slam Stick X sales department at 781-306-0609 extension 239. We can also be reached by email at service@mide.com.

Please note that product specifications are subject to change without notice. This often occurs due to Midé's continued effort to improve the features and functionality of this product. For software updates, up-to-date user guide, datasheet and other product information please visit our website at www.mide.com. Midé's sales and technical staff would also be happy to help with any inquires of updated product information.

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